

What is Claimed is:

- 1 1. A method for removing a metallic layer formed from at least one metal from the  
2 surface of a ceramic substrate, said method comprising the step of immersing the ceramic  
3 substrate coated with the metallic layer in an acid solution of up to about 31% hydrochloric  
4 acid for a time to substantially remove the metallic layer therefrom.
- 1 2. The method of Claim 1, wherein the acid solution comprises hydrochloric acid at a  
2 concentration of about 31 % by volume of the solution.
- 1 3. The method of Claim 1, wherein the metallic layer further comprises a composite  
2 layer formed from an aluminum coating in contact with the ceramic substrate and a tantalum  
3 deposition overlaying the aluminum coating.
- 1 4. The method of Claim 2, further comprising subsequent to said immersing step, the  
2 step of annealing the ceramic substrate at a predetermined temperature sufficient to at least  
3 reduce pre-existing damage in the surface of the ceramic substrate.
- 1 5. The method of Claim 3, further comprising subsequent to said immersing step, the  
2 step of annealing the ceramic substrate at an elevated temperature sufficient to at least reduce  
3 pre-existing damage in the surface of the ceramic substrate via annealing.

1 6. The method of Claim 4, wherein the annealing step further comprises ramping the  
2 temperature using at least one predetermined heating ramp rate.

1 7. The method of Claim 5, wherein the annealing step further comprises ramping the  
2 temperature using at least one predetermined heating ramp rate.

1 8. The method of Claim 1, further including subsequent to the immersing step, the step  
2 of immersing said substrate in an acid bath containing a solution of nitric acid ( $\text{HNO}_3$ ) and  
3 hydrofluoric (HF) acid to remove stains.

1 9. The method of Claim 8, wherein the acid bath contains equal parts of water, nitric  
2 acid, and hydrofluoric acid.

1 10. The method of Claim 2, further including subsequent to the immersing step, the step  
2 of immersing said substrate in an acid bath containing a solution of nitric acid ( $\text{HNO}_3$ ) and  
3 hydrofluoric (HF) acid to remove stains.

1 11. The method of Claim 10, wherein the  $\text{HNO}_3$ /HF acid bath contains equal parts of  
2 water, nitric acid, and hydrofluoric acid.

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1 12. The method of Claim 6, wherein the ramping step further comprises:  
2 heating to a first temperature of about 302°F at a first heating ramp rate of about  
3 122°F/hour;  
4 maintaining the first temperature for about an hour;  
5 heating to a second temperature of about 752°F at a second heating ramp rate of about  
6 212°F/hour;  
7 heating to a third temperature of about 1652°F at a third heating ramp rate of about  
8 347°F/hour;  
9 maintaining the third temperature for about 7 hours; and  
10 allowing to cool to a fourth temperature of about 100°F at a cooling ramp rate of  
11 about minus 210°F/hour.

1 13. The method of Claim 6, wherein the ramping step further comprises:  
2 heating to a first temperature of about 302°F at a first heating ramp rate of about  
3 122°F/hour; and  
4 maintaining the first temperature for about an hour.  
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1 14. The method of Claim 13, wherein the ramping step further comprises:  
2 heating to a second temperature of about 752°F at a second heating ramp rate of about  
3 212°F/hour.

1 15. The method of Claim 14, wherein the ramping step further comprises:  
2 heating to a third temperature of about 1652°F at a third heating ramp rate of about  
3 347°F/hour; and  
4 maintaining the temperature for about 7 hours.

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1 16. The method of Claim 15, wherein the ramping step further comprises:  
2 allowing to cool to a fourth temperature of about 100°F at a cooling ramp rate of  
3 about minus 210°F/hour.

1 17. The method of Claim 7, wherein the ramping step further comprises:  
2 heating to a first temperature of from about 302°F at a first heating ramp rate of about  
3 122°F/hour;  
4 maintaining the first temperature for about an hour;  
5 heating to a second temperature of about 752°F at a second heating ramp rate of about  
6 212°F/hour;  
7 heating to a third temperature of about 1652°F at a third heating ramp rate of about  
8 347°F/hour;  
9 maintaining the third temperature for about 7 hours; and  
10 allowing to cool to a fourth temperature of about 100°F at a cooling ramp rate of  
11 about minus 210°F/hour.

1 18. The method of Claim 7, wherein the ramping step further comprises:  
2 heating to a first temperature of about 302°F at a first heating ramp rate of about  
3 122°F/hour; and  
4 maintaining the first temperature for about an hour.

1 19. The method of Claim 18, wherein the ramping step further comprises:  
2 heating to a second temperature of about 752°F at a second heating ramp rate of about  
3 212°F/hour.

1 20. The method of Claim 19, wherein the ramping step further comprises:  
2 heating to a third temperature of about 1652°F at a third heating ramp rate of about  
3 347°F/hour; and  
4 maintaining the temperature for about 7 hours.

1 21. The method of Claim 20, wherein the ramping step further comprises:  
2 allowing to cool to a fourth temperature of about 100°F at a cooling ramp rate of  
3 about minus 210°F/hour.

1 22. The method of Claim 2, wherein the temperature of the HCl acid solution is  
2 maintained at ambient.

1 23. The method of Claim 22, wherein the ceramic substrate is immersed in the HCl acid  
2 solution for about 15 minutes to an hour.

1 24. A method for removing a metallic layer formed from at least one metal from the  
2 surface of a ceramic substrate, said method comprising the steps of:

3 immersing the ceramic substrate coated with the metallic layer formed from one metal in  
4 an acid solution for a time to remove at least a portion of the metallic layer therefrom; and  
5 annealing the ceramic substrate subsequent to said immersion step at an elevated  
6 temperature sufficient to at least reduce pre-existing damage in the surface of the substrate.

1 25. The method of Claim 24, wherein the acid solution comprises hydrochloric acid at a  
2 concentration of up to 31 % by volume of the solution.

1 26. The method of Claim 24, wherein the acid solution comprises hydrochloric acid at a  
2 concentration of about 31 % by volume of the solution.

1 27. The method of Claim 24, wherein the metallic layer further comprises a composite  
2 layer formed from an aluminum coating in contact with the ceramic substrate and a tantalum  
3 deposition overlaying the aluminum coating.

1 28. The method of Claim 24, wherein the annealing step further comprises ramping the  
2 temperature using at least one predetermined heating ramp rate.

1    29.    The method of Claim 28, wherein the ramping step further comprises:  
2           heating to a first temperature of about 302°F at a first heating ramp rate of about  
3           122°F/hour;  
4           maintaining the first temperature for about an hour;  
5           heating to a second temperature of about 752°F at a second heating ramp rate of about  
6    212°F/hour;  
7           heating to a third temperature of about 1652°F at a third heating ramp rate of about  
8    347°F/hour;  
9           maintaining the third temperature for about 7 hours; and  
10          allowing to cool to a fourth temperature of about 100°F at a cooling ramp rate of  
11    about minus 210°F/hour.

1    30.    The method of Claim 28, wherein the ramping step further comprises:  
2           heating to a first temperature of about 302°F at a first heating ramp rate of about  
3    122°F/hour ; and  
4           maintaining the first temperature for about an hour.

1    31.    The method of Claim 30, wherein the ramping step further comprises:  
2           heating to a second temperature of about 752°F at a second heating ramp rate of about  
3    212°F/hour.

1    32.    The method of Claim 31, wherein the ramping step further comprises:

2 heating to a third temperature of about 1652°F at a third heating ramp rate of about  
3 347°F/hour; and  
4 maintaining the third temperature for about 7 hours.

1 33. The method of Claim 32, wherein the ramping step further comprises:  
2 allowing to cool to a fourth temperature of about 100°F at a cooling ramp rate of  
3 about minus 210°F/hour.

1 34. The method of Claim 26, wherein the temperature of the HCl acid solution is  
2 maintained at ambient.

1 35. The method of Claim 34, wherein the ceramic substrate is immersed in the HCl acid  
2 solution for about 15 minutes to an hour.

1 36. The method of Claim 25, wherein the heat treating step further comprises ramping the  
2 temperature using at least one predetermined heating ramp rate.

37. The method of Claim 36, wherein the ramping step further comprises:  
1 heating to a first temperature of from about 302°F at a first heating ramp rate of about  
2 122°F/hour;  
3 maintaining the first temperature for about an hour;  
4 heating to a second temperature of about 752°F at a second heating ramp rate of about  
5 212°F/hour;



6           heating to a third temperature of about 1652°F at a third heating ramp rate of about  
7   347°F/hour;  
8           maintaining the third temperature for about 7 hours; and  
9           allowing to cool to a fourth temperature of about 100°F at a cooling ramp rate of  
10   about minus 210°F/hour.

1   38.    The method of Claim 36, wherein the ramping step further comprises:  
2           heating to a first temperature of about 302°F at a first heating ramp rate of about  
3           122°F/hour; and  
4           maintaining the temperature for about an hour.

1   39.    The method of Claim 38, wherein the ramping step further comprises:  
2           heating to a second temperature of about 752°F at a second heating ramp rate of about  
3   212°F/hour.

1   40.    The method of Claim 39, wherein the ramping step further comprises:  
2           heating to a third temperature of about 1652°F at a third heating ramp rate of about  
3   347°F/hour; and  
4           maintaining the temperature for about 7 hours.

1 41. The method of Claim 40, wherein the ramping step further comprises:  
2 allowing to cool to a fourth temperature of about 100°F at a cooling ramp rate of  
3 about minus 210°F/hour.

1 42. A method for refurbishing a deposition ring comprising a ceramic substrate coated  
2 with a metallic composite layer having an aluminum layer in contact with the surface of the  
3 ceramic substrate and a tantalum layer in deposited over the aluminum layer, said method  
4 comprising the steps of:  
5 immersing the ceramic substrate coated with the metallic composite layer in a solution  
6 of up to 31% hydrochloric acid (HCl), for a time to remove at least a portion of the metallic  
7 layer therefrom;  
8 removing the ceramic substrate from the acid solution;  
9 rinsing the ceramic substrate in a rinse solution;  
10 drying the substrate; and  
11 • coating the ceramic substrate with a new metallic layer.

1 43. The method of Claim 42, further comprising, before said coating step, the step of  
2 annealing the ceramic substrate at a predetermined temperature for a sufficient time to at least  
3 reduce damage or defects in the surface of the ceramic substrate.

1 44. The method of Claim 42, further comprising after said rinsing step, the step of  
2 immersing said substrate in an acid bath solution of  $\text{HNO}_3$  and HF to remove stains,  
3 whereafter another step of rinsing is made.

1 45. The method of Claim 44, wherein the acid bath solution contains equal parts of  $\text{H}_2\text{O}$ ,  
2  $\text{HNO}_3$  and HF.

1 46. The method of Claim 44, further comprising before said coating step, the step of  
2 drying said substrate at a predetermined temperature for a predetermined time.

1 47. The method of Claim 46, wherein said predetermined temperature is 250°F, and said  
2 predetermined time is about an hour.

1 48. The method of Claim 43, wherein the annealing step further comprises ramping the  
2 temperature using at least one predetermined heating ramp rate.

1 49. The method of Claim 48, wherein the ramping step further comprises:  
2 heating to a first temperature of from about 302°F at a first heating ramp rate of about  
3 122°F/hour;  
4 maintaining the first temperature for about an hour;  
5 heating to a second temperature of about 752°F at a second heating ramp rate of about  
6 212°F/hour;

7 heating to a third temperature of about 1652°F at a third heating ramp rate of about  
8 347°F/hour;  
9 maintaining the third temperature for about 7 hours; and  
10 allowing to cool to a fourth temperature of about 100°F at a cooling ramp rate of  
11 about minus 210°F/hour.

1 50. The method of Claim 48, wherein the ramping step further comprises:  
2 heating to a first temperature of about 302°F at a first heating ramp rate of about  
3 122°F/hour; and  
4 maintaining the first temperature for about an hour.

1 51. The method of Claim 50, wherein the ramping step further comprises:  
2 heating to a second temperature of about 752°F at a second heating ramp rate of about  
3 212°F/hour.

1 52. The method of Claim 51, wherein the ramping step further comprises:  
2 heating to a third temperature of about 1652°F at a third heating ramp rate of about  
3 347°F/hour; and  
4 maintaining the third temperature for about 7 hours.

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1 53. The method of Claim 52, wherein the ramping step further comprises:  
2 allowing to cool to a fourth temperature of about 100°F at a cooling ramp rate of  
3 about minus 210°F/hour.

1 54. The method of Claim 42, wherein the acid solution is about 31% HCl.

1 55. A method for refurbishing a deposition ring comprising a ceramic substrate coated  
2 with a metallic composite layer having an aluminum layer in contact with the surface of the  
3 ceramic substrate and a tantalum layer in deposited over the aluminum layer, said method  
4 comprising the steps of:  
5 immersing the ceramic substrate coated with the metallic composite layer in an acid  
6 solution, for a sufficient time to substantially remove the metallic layer therefrom;  
7 removing the ceramic substrate from the acid solution;  
8 rinsing the ceramic substrate in a rinse solution;  
9 drying the substrate;  
10 annealing the ceramic substrate at a predetermined temperature for a sufficient time to  
11 at least reduce damage or defects in the surface of the ceramic substrate; and  
12 coating the ceramic substrate with a new metallic layer.

1 56. The method of Claim 55, wherein the acid solution includes about 31% hydrochloric  
2 acid.

1 57. The method of Claim 56, wherein the annealing step further comprises ramping the  
2 temperature using at least one predetermined heating ramp rate.

1 58. The method of Claim 57, wherein the ramping step further comprises:  
2 heating to a first temperature of from about 302°F at a first heating ramp rate of about  
3 122°F/hour;  
4 maintaining the first temperature for about an hour;  
5 heating to a second temperature of about 752°F at a second heating ramp rate of about  
6 212°F/hour;  
7 heating to a third temperature of about 1652°F at a third heating ramp rate of about  
8 347°F/hour;  
9 maintaining the third temperature for about 7 hours; and  
10 allowing to cool to a fourth temperature of about 100°F at a cooling ramp rate of  
11 about minus 210°F/hour.

1 59. The method of Claim 57, wherein the ramping step further comprises:  
2 heating to a first temperature of about 302°F at a first heating ramp rate of about  
3 122°F/hour; and  
4 maintaining the first temperature for about an hour.  
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1 60. The method of Claim 59, wherein the ramping step further comprises:  
2 heating to a second temperature of about 752°F at a second heating ramp rate of about  
3 212°F/hour.

1 61. The method of Claim 60, wherein the ramping step further comprises:  
2 heating to a third temperature of about 1652°F at a third heating ramp rate of about  
3 347°F/hour; and  
4 maintaining the third temperature for about 7 hours.

1 62. The method of Claim 61, wherein the ramping step further comprises:  
2 allowing to cool to a fourth temperature of about 100°F at a cooling ramp rate of  
3 about minus 210°F/hour.